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## Docket Number:

David R. Hall

Enclosed are:

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|-------------------------------------|----|--|
| <input checked="" type="checkbox"/> | 15 | pages of written description, claims and abstract.                             |
| <input checked="" type="checkbox"/> | 3  | sheets of drawings.  |
| <input type="checkbox"/>            |    | an assignment of the invention _____   |
| <input checked="" type="checkbox"/> |    | executed declaration of the inventors.   |
| <input type="checkbox"/>            |    | a certified copy of a _____ application.                                       |
| <input type="checkbox"/>            |    | associate power of attorney.   |
| <input checked="" type="checkbox"/> |    | verified statement to establish small entity status under 37 CFR 1.9 and 1.27. |
| <input type="checkbox"/>            |    | information disclosure statement.  |
| <input type="checkbox"/>            |    | preliminary amendment.   |
| <input type="checkbox"/>            |    | other: _____.  |

## CLAIMS AS FILED

CLAIMS AS FILED				
	NUMBER FILED	NUMBER EXTRA	RATE	FEE
BASIC FEE			\$690	\$ 690.00
TOTAL CLAIMS	16	0	x\$22	0
INDEPENDENT CLAIMS	2	0	\$ 78.00	\$ -
MULTIPLE DEPENDENT CLAIM PRESENT			\$270	0
			TOTAL	\$ 345.00
If applicant has small entity status under 37 CFR 1.9 and 1.27, then divide total fee by 2, and enter amount here.			SMALL ENTITY TOTAL	ONE HALF \$ 345.00

- ☒ A check in the amount of \$345.00 to cover the filing fee is enclosed.
- ☐ The commissioner is hereby authorized to charge and credit Deposit Account No. \_\_\_\_\_ as described below. I have enclosed a duplicate copy of this sheet.
- ☐ Charge the amount of \$\_\_\_\_\_ as filing fee.
- ☐ Credit any overpayment.
- ☐ Charge any additional filing fees required under 37 CFR 1.16 and 1.17.
- ☐ Charge the issue fee set in 37 CFR 1.189 at the mailing of the Notice of Allowance, pursuant to 37 CFR 1.311(b).

7-18-00  
Date

  
Signature

DAVID R. HALL  
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Address

[illegible]

Date: 7-18-00

## **TITLE**

A Repeatable Reference For Positioning Sensors And Transducers In Drill Pipe

## **RELATED APPLICATIONS**

5           None

## **BACKGROUND OF THE INVENTION**

10           This invention relates to adapting drill pipe for use in the oil, gas, and geothermal drilling industries for power and data transmission. More particularly, this invention relates to providing a repeatable reference for positioning and tuning connectors, transducers, and sensors along the drill string and within the drill pipe joint.

15           The need for acquisition and bi-directional transmission of power and data along the drill string has been recognized for more than half a century, and as exploration and drilling technology have improved, this need has become more and more an imperative in the industry for successful oil, gas, and geothermal well production. However, despite a plethora of literature in this area, the only system to gain commercial acceptance uses pressure impulses transmitted through the drilling fluid as a means for data communication. The chief drawbacks to this system are that the data rate is very slow, less than 10  
20    baud; the system is very complex and expensive; the results are inconsistent; and range of performance is limited. It appears that the other proposed systems have not gained commercial acceptance due to the unique characteristics of the drill pipe tool joint. The following patents exhibit some of the relevant systems proposed to accomplish this most critical task.

25           U.S. Patent No. 3696332, incorporated herein by this reference, teaches the use of an electrical conductor extended along the interior of each pipe and connected to an annular groove within the pipe joint.

U.S Patent No. 3930220, incorporated herein by this reference, teaches an acoustic system using repeaters along the drill string to prevent the loss of the signal being transmitted.

U.S. Patent No. 4548431, incorporated herein by this reference, teaches a double shouldered tool joint. The tool joint has both internal and external makeup shoulders. The pin and box are dimensioned so that box face contacts the external shoulder while there is still a clearance the pin face and the internal shoulder. This joint is strengthened against the additional torque that may be encountered downhole when the bit or drill pipe gets stuck.

U.S. Patent No. 4807781, incorporated herein by this reference, is another patent that teaches a telemetry system. Sensors are disclosed that measure such parameters as pressure, temperature, salinity, direction of well bore, bit conditions, as well as the standard well logging parameters. The sensor outputs are converted to a digital form and stored until called for from the surface. Transmission is accomplished by low frequency modulation of a carrier wave in the 1 – 30 hertz range. The system, including periodic repeaters, is positioned within the bore of the drill pipe without substantially decreasing the clearance for mud flow.

U.S. Patent No. 4095865, incorporated herein by this reference, teaches the use of a conduit deployed within the drill pipe as a conveyance for the insulated conductor and means for attaching the conduit to the pipe wall.

U.S. Patent No. 4215426 teaches a system in which wiring extends through the drill pipe employing magnetic coupling between the pipe sections. The use of signal enforcers is also taught. Power transmission is achieve by means of an acoustic power generator and a means for converting the acoustic wave to a DC voltage.

U.S. Patent No. 4220381, incorporated herein by this reference, teaches the use of a conductor wire in each pipe section connected to electrodes that are exposed to the drilling fluid in each joint. A high voltage is used to hop the current across the joint and thereby provide and link between each pipe  
5 section.

U.S. Patent No. 4445734, incorporated herein by this reference, teaches the use of a wire secured within the pipe by a liner. The wire is connected to annular contacts at each joint. The contact mechanism includes a means for wiping the surfaces of the contacts and of exerting pressure on the contacts in  
10 order to ensure efficient signal transmission.

U.S. Patent No. 4884071, incorporated herein by this reference, teaches the use of a Hall Effect coupler. A self-contained power supply is located at each joint and coupled to the Hall Effect device sending and receiving units. A conductor wire, shielded by a conduit, extends along the pipe bore and  
15 connects couplers at each end of the pipe.

U. S. Patent No. 5568448, incorporated herein by this reference, teaches the use of an ultrasonic wave that is propagated through a propagation medium. An acoustic waver receiver converts the wave to an electric signal.

U.S. Patent No. 6041872, incorporated herein by this reference, teaches  
20 the use of a disposable cable deployed along the bore of the drill string. It is deployed from a spool at the bottom of the drill string and fed out as the drill pipes are added. When pipes sections are removed, the cable is cut off and disposed of. A data transmission device is connected to the cable. The cable may be suitable for electromagnetic or fiber optic communications.

U.S. Patent No. 5908212, incorporated herein by this reference, teaches  
25 a double shouldered tool joint capable of sustaining high torque. The disclosure identifies a relationship between the cross-sectional areas of the

nose section of the pin end and the counter bore section of the box end. The sum of these two areas are correlated with cross-sectional area of the joint wall adjacent the internal shoulder of the box end.

U.S. Patent No. 6057784, also incorporated herein, discloses another combination electromagnetic mud impulse system. Data from sensors at the bit is transmitted by means of an electromagnetic wave to a receiver that converts the wave into a pressure pulse in the drilling fluid for transmission up hole.

What is needed then is a tool joint that provides a repeatable reference for precise positioning and tuning of connectors, sensors, and transducers disposed within the tool joint and at locations along the drill string.

## **SUMMARY OF THE INVENTION**

This disclosure presents a drill pipe and tool joint adapted for power and data acquisition and transmission that will enable communication along the drill string. In order to achieve communication along the drill string, the connectors, sensors, and transducers, and means for power and data transmission must be precisely positioned along the drill pipe and within the tool joint. This disclosure provides a tool joint having a precise, repeatable plane of reference that can be used for positioning communication devices within the joint and along the drill string.

This disclosure enables precise positioning of connectors and tuning of downhole sensors and transducers by deploying them in reference to a predictable plane established within the tool joint by the axial alignment of the internal shoulder of the box end and the external face of the pin end. This alignment is achieved by precisely coordinating the dimensions of the pin end joint with the dimensions of the box end joint so that a predictable plane of reference is established. The reference plane is within the box end joint and

results from the differences in the lengths between the internal shoulder and external face of the box, and between the external shoulder and the external face of the pin end; the box length being greater than the pin length. As the mating joints are engaged and makeup torque is achieved, the differences in length result in a predictable plane of contact or a gap between the pin face and the internal shoulder of the box end. This predictable plane of contact or gap, then, establishes a repeatable plane of reference. In tool joints employing shoulders as a means for producing makeup torque, sensors and transducers may be installed at locations along the pipe or within the joint in precise reference to the external shoulder and external face of the pin end, or in reference to the internal shoulder and external shoulder of the box end. In tool joints where the threads are used to achieve makeup torque without loading the shoulders, the mating threads may be timed in order to produce a repeatable reference contact or non-contact plane. In this manner, when the tool joints are made up and makeup torque is achieved, the sensors and transducers will be located at predictable and repeatable distances apart to enable precise positioning and tuning.

An additional benefit of this invention is that sensors located in reference to the repeatable plane of reference may be used to reliably indicate makeup torque and additional torsional loads placed upon of the drill pipe and the drill string during drilling. Such information is valuable in order to ensure proper drill string makeup and to prevent over-torque conditions and twist offs during drilling.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1 is a representation of a tool joint depicting the repeatable reference.

Figure 2 is a representation of the present invention in a tool joint having interlocking threads that carry the loads of joint makeup.

Figure 3 is a representation of tool joint wherein only one shoulder is loaded when the joint is made-up.

## 5 DETAILED DESCRIPTION OF THE INVENTION

The need for power transmission and high-speed data acquisition and transmission of well drilling parameters has long been recognized. However, to date, the only system that has gained commercial acceptance is the mud pulse system. The chief drawbacks of the mud pulse system are its slow data rates,  
10 the limited range of data that may be transmitted, its complexity, and its inconsistent results. What is need is a drill pipe and tool joint that are adapted for high- speed data communication all along the drill string. This invention relates to adapting drill pipe for use in the oil, gas, and geothermal drilling industries for data acquisition and transmission. This patent discloses a drill  
15 pipe and tool joint having a repeatable, predictable reference for positioning and tuning transducers and sensors positioned along the drill string.

This disclosure enables precise positioning and tuning of downhole sensors and transducers by deploying them in reference to a predictable plane established within the tool joint by the axial alignment of the internal shoulder  
20 of the box end and the external face of the pin end. This alignment is achieved by coordinating the dimensions of the pin end joint with the dimensions of the box end joint so that a predictable plane of reference is established. The reference plane is within the box end joint and results from the differences in the lengths between the internal shoulder and external face of the box, and  
25 between the external shoulder and the external face of the pin end; the box length being greater than the pin length. As the mating joints are engaged and makeup torque is achieved, the differences in length result in predictable gap







connectors, sensors, or transducers. Repeatable gap C should be less than 1.0 inches and preferably less than 0.100 inches. It may be desirable that grooves 32 are disposed adjacent one another at joint makeup, producing a situation wherein the power and data transmitting components 36 are in close proximity or in contact with one another. The applicants believe that the repeatable plane of reference is essential for power and data transmission across the tool joint, as well as for optimizing the use of connectors, transducers, or sensors in the tool joint and along the drill pipe.

Figure 3 is another representation of a portion of a drill pipe joint. The principles discussed herein are applicable whether the shoulder or interlocking threads are used to achieve tool joint makeup torque. Makeup torque of the tool joint is determined in reference to the torsional strength of the drill pipe tubular and the torsional strength of the tool joint, itself. It is usually between approximately one half to three quarters the torsional strength of the drill pipe. The torsional strength of the drill pipe and the tool joint is dependent on a number of factors, including the alloy composition of the material, its metallurgical properties, and the cross sectional area of the pipe and the joint F. Therefore, the weakest portion of the joint is where the cross sectional area is the least, which are the nose portion of the pin end D and the counter bore portion of the box end E. In applications where connectors, transducers, or sensors are disposed within a radial or axial groove within the wall of the pipe or joint, and the area of the groove 38 compromises the torsional strength of the drill pipe or joint, the cross sectional area of the pipe wall F may be increased from diameter 39 to diameter 41 in order to maintain the integrity of the pipe or joint.

Those skilled in the art will immediately recognize applications and variations of the invention claimed herein, and such are included within the scope of this disclosure.

## CLAIMS

What is claimed:

1. A high strength drill pipe joint suitable for power transmission and data acquisition and transmission, comprising:
  - a. a first length of drill pipe comprising a box end and a pin end and second length of drill pipe comprising a pin end and a box end for interconnection as tool joints;
  - b. the box ends comprising an external face, a counterbore, a tapered thread, and an internal shoulder section proportioned to sustain at least a nominal makeup torque;
  - c. the pin ends comprising a external face, a nose section, a tapered thread, a base section; and an external shoulder proportioned to sustain a at least a nominal makeup torque;
  - d. the distance between the internal shoulder and external face of the box end being precisely greater than the distance between the external face and shoulder of the pin end so as to describe a precise distance between said internal shoulder and said external face;
  - e. the first drill pipe comprising at least one means for power transmission or for data acquisition or transmission located in precise reference to the internal shoulder within its box end and the second drill pipe comprising at least one means for data acquisition or transmission located in precise reference to the external face of its pin end; and
  - f. when the tool joint is made up, said internal shoulder of the box end and said external face of the pin end coming into repeatable, predetermined proximity in such a manner that the distance

between the respective means for data acquisition or transmission is substantially constant, enabling precise tuning of said means.

2. The drill pipe joint of claim 1, wherein the first and second lengths of drill pipe are connected to other similarly configured lengths of drill pipe to form a drill string for oil, gas, and geothermal well drilling.
3. The drill pipe joint of claim 1, wherein the lengths of drill pipe are connected to the group consisting of downhole tools, including drill bits, having similarly configured drill pipe joints.
4. The drill pipe joint of claim 1, wherein, when the tool joint is connected under a nominal makeup torque, the distance between the internal shoulder of the box end and the external face of the pin end is between .003 and .010 inches.
5. The drill pipe joint of claim 1, wherein the drill pipe comprises a combination of data acquisition and data transmission means.
6. The drill pipe joint of claim 1, wherein, when the tool joint is made up under a nominal makeup torque, the predetermined distance between the means for data acquisition or transmission is less than .010 inches.
7. The drill pipe joint of claim 1, wherein the makeup torque is at least approximately 0.5 times the torsional yield strength of the tool joint.
8. The drill pipe joint of claim 1, wherein the tool joint is capable of sustaining an additional torque of approximately 1.25 times the makeup torque.
9. The high strength drill pipe joint of claim 1, wherein, when the means for data acquisition or transmission are located within the box end of the drill pipe, the cross-sectional area of the counterbore and

internal shoulder, and the tapered thread are further proportioned to sustain a nominal makeup torque;

10. The high strength drill pipe joint of claim 1, wherein, when the means for data acquisition or transmission are located within nose section of the pin end of the drill pipe, the nose section, tapered thread, base section, and external shoulder are further proportioned to sustain a nominal makeup torque.

11. The high strength drill pipe joint of claim 9, wherein said joint is capable of sustaining an additional torque of approximately 1.25 times the nominal makeup torque.

12. The high strength drill pipe joint of claim 10, wherein said joint is capable of sustaining an additional torque of approximately 1.25 times the nominal makeup torque.

13. The high strength drill pipe joint of claim 1, wherein, when an additional torque of approximately 1.25 times the nominal torque is applied to the joint, the predetermined distance between the respective means for data acquisition or transmission is less than .010 inches.

14. The high strength drill pipe of claim 1, wherein the data acquisition means is selected from the group consisting of conductors, accelerometers, potentiometers, gamma ray sensors, thermocouples, pressure transducers, inclinometers, magnetometers, chemical sensors, or acoustic transducers.

15. The high strength drill pipe of claim 1, wherein the data transmission means is selected from the group consisting of conductors, or optical, electrical, electromagnetic, or acoustic sending and receiving means.





## ABSTRACT

A drill pipe having a box end having a tapered thread, and an internal shoulder and an external face for engagement with a drill pipe pin end having a tapered mating thread, and an external shoulder and an external face adapted for data acquisition or transmission. The relative dimensions of the box and pin ends are precisely controlled so that when the tool joint is made up, a repeatable reference plane is established for transmitting power and tuning downhole sensors, transducers, and means for sending and receiving data along the drill string. When the power or data acquisition and transmission means are located in the tool joint, the dimensions of the tool joint are further proportioned to compensate for the loss of cross-sectional area in order maintain the joints ability to sustain nominal makeup torque.



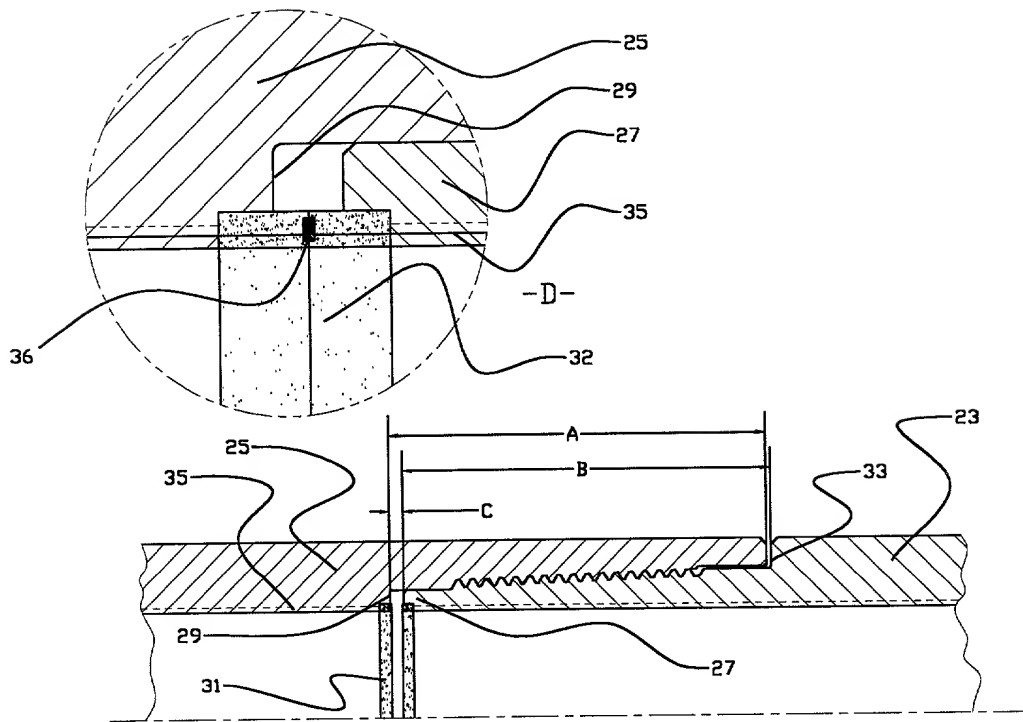
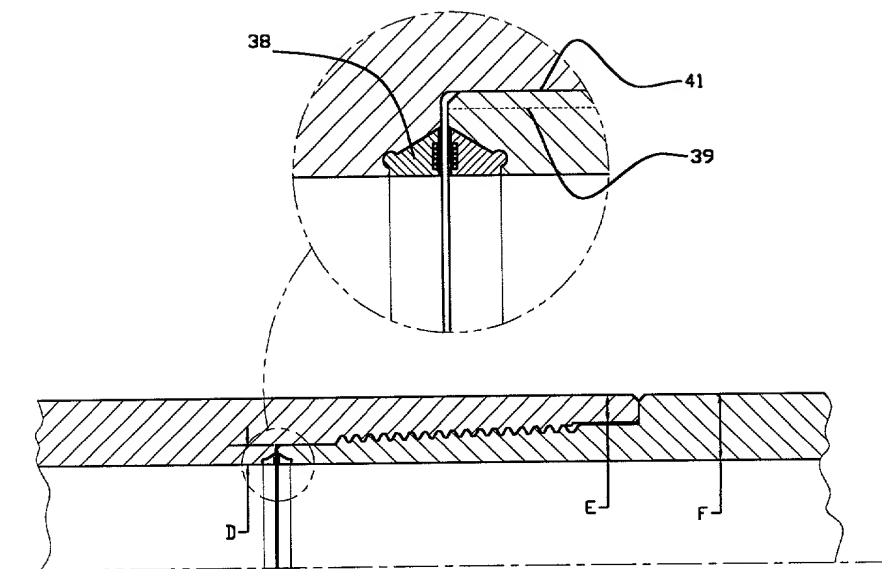


Fig. 2



**Fig. 3**

[illegible]

My residence, post office address and citizenship are as stated below next to my name.

checked:  
☐ was filed on \_\_\_\_\_ as United States Application Number or PCT International Application  
 Number \_\_\_\_\_ and was amended on \_\_\_\_\_ (if applicable).

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, 1.56.

None \_\_\_\_\_ Yes ☒ No

(Number) (Country) (Day/Month/Year Filed)

None		
(Application Number)	(Filing Date)	(Status - patented, pending, abandoned)

Address all correspondence and telephone calls to the inventors listed below.

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☒ Additional inventors are being named on separately numbered sheets attached hereto.

Age group (years)	Number of cases	Number of deaths	Number of survivors	Number of cases with sequelae	Number of cases with sequelae (%)
0-4	10	0	10	0	0
5-9	10	0	10	0	0
10-14	10	0	10	0	0
15-19	10	0	10	0	0
20-24	10	0	10	0	0
25-29	10	0	10	0	0
30-34	10	0	10	0	0
35-39	10	0	10	0	0
40-44	10	0	10	0	0
45-49	10	0	10	0	0
50-54	10	0	10	0	0
55-59	10	0	10	0	0
60-64	10	0	10	0	0
65-69	10	0	10	0	0
70-74	10	0	10	0	0
75-79	10	0	10	0	0
80-84	10	0	10	0	0
85-89	10	0	10	0	0
90-94	10	0	10	0	0
95-99	10	0	10	0	0
100+	10	0	10	0	0
Total	100	0	100	0	0

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